Kelly KDC Series/PM Motor Controller User's Manual

KDC48600
KDC48601
KDC48602
KDC48603
KDC72600
KDC72601
KDC72602
KDC72603
KDC72800
KDC72801
KDC72802
KDC72803
KDC12602
KDC12603

Rev.3.3
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Contents

Chapter 1 Introduction

1.1 Overview

This manual introduces the Kelly KDC Series/PM Motor controllers' features, their installation and thier maintenance. Read the manual carefully and thoroughly before using the controller. If you have any questions, please contact the support center of Kelly Controls, LLC.

Kelly's programmable motor controllers provide efficient, smooth and quiet controls for electric vehicles like golf carts, go-carts, electric motorcycles, forklifts and hybrid vehicles, as well as electric boats and industries motor speed control. It uses high power MOSFET's and, fast PWM to achieve efficiencies of up to 99% in most cases. A powerful microprocessor brings in comprehensive and precise control to the controllers. It also allows users to adjust parameters, conduct tests, and obtain diagnostic information quickly and easily.

Chapter 2 Main Features and Specifications

2.1 General functions

(1) Extended fault detection and protection. LED flashing code indicates fault sources.
(2) Monitoring battery voltage. It will stop driving if battery voltage is too high. It will cut back then stop driving if voltage is going too low.
(3) Built-in current loop and over current protection.
(4) Motor temperature input and protection. Configurable range.
(5) Cutting back current at low temperature and high temperature to protect battery and controller. The current will ramp down quickly if controller temperature is higher than 90℃, and shutdown at 100℃. Low temperature current ramping down usually starts at 0℃.
(6) The controller keeps monitoring voltage during regen. It will cut back current then cut off regen if voltage is going too high.
(7) Configurable to limit max reverse speed to half of max forward speed.
(8) Configurable and programmable with a host computer though RS232 or USB. Provide free GUI which can run on Windows XP/2000, Windows 7 and Vista(recommend using Kelly Standard USB To RS232 Converter).
(9) Provide power supply (5V) for hall sensors and other sensors.
(10) 3 switch inputs: Default to throttle switch, brake switch and reversing switch. Closing to ground is to activate.
(11) 3 analog inputs, 0-5V: Default to throttle input, brake input and motor temperature input.
(12) PWMable reverse alarm output.
(13) Main contactor driver. Cutting off the power if any fault is detected.
(14) Configurable max reverse power to half.
(15)Thermal overload detection and protection to safeguard the motor from over temperature (designed using Silicon temperature sensors KTY83-122).
(16) Optional CAN bus.
(17) 18V-120V power supply for 120V controller.

Caution! Regeneration has braking effect, but can't replace mechanical brake. Mechanical brake is required to stop your vehicle. Regen isn't a safety feature! Controller may stop regen to protect itself (not you!).

2.2 Features

•Intelligence with powerful microprocessor.
•Synchronous rectification, ultra low drop, and fast PWM to achieve very high efficiency.
•Voltage monitoring on voltage source 12V and 5V.
•Hardware over current protection.
•Hardware over voltage protection.
•Current limit and torque control.
•Low EMC.
•LED fault code.
•Battery protection: current cutback, warning and shutdown at configurable high and low

battery voltage.

• Rugged aluminum housing for maximum heat dissipation and harsh environment.

•Rugged high current terminals, and rugged aviation connectors for small signal.

•Thermal protection: current cut back, warning and shutdown on high temperature.

•Configuring current-voltage mode of field function on controller with field to achieve more reliable.

•Configurable high pedal protection: Disable operation if power up with high throttle.

•Brake switch is used to start regen.

•0-5V brake signal is used to command regen current.

•Standard PC/Laptop computer to do programming. No special tools needed.

•User program provided. Easy to use. No cost to customers.

2.3 Specifications

•Frequency of Operation: 16.6kHz.

•Standby Battery Current: < 0.5mA.

•Controller power supply current, PWR, <150mA.

•Configurable battery voltage range, B+. Max operating range: 18V to 136V

•Standard Throttle Input: 0-5 Volts(3-wire resistive pot), 1-4 Volts(hall active throttle).

•Analog Brake and Throttle Input: 0-5 Volts. Producing 0-5V signal with 3-wire pot.

•Reverse Alarm, Main Contactor Coil Driver, Meter.

•Full Power Temperature Range: 0℃ to 40℃ (controller case temperature).

•Operating Temperature Range: -30℃ to 90℃, 100℃ shutdown (controller case temperature).

•Motor Current Limit, 1 minutes: 600-800A, depending on the model.

•Motor Current Limit, continuous:240-320A, depending on the model.

Kelly KDC Series/PM Motor Controller						
Model	1 minutes current	continuous current	Nominal Voltage Range	Max operating voltage	Field	Regen
KDC48600	600A	240A	24V-48V	18V-60V		
KDC48601	600A	240A	24V-48V	18V-60V		*
KDC48602	600A	240A	24V-48V	18V-60V	*	
KDC48603	600A	240A	24V-48V	18V-60V	*	*
KDC72600	600A	240A	24V-72V	18V-90V		
KDC72601	600A	240A	24V-72V	18V-90V		*
KDC72602	600A	240A	24V-72V	18V-90V	*	
KDC72603	600A	240A	24V-72V	18V-90V	*	*
KDC72800	800A	320A	24V-72V	18V-90V		
KDC72801	800A	320A	24V-72V	18V-90V		*
KDC72802	800A	320A	24V-72V	18V-90V	*	
KDC72803	800A	320A	24V-72V	18V-90V	*	*
KDC12602	600A	240A	24V-120V	18V-136V	*	
KDC12603	600A	240A	24V-120V	18V-136V	*	*

Chapter 3 Wiring and Installation

3.1 Mounting the Controller

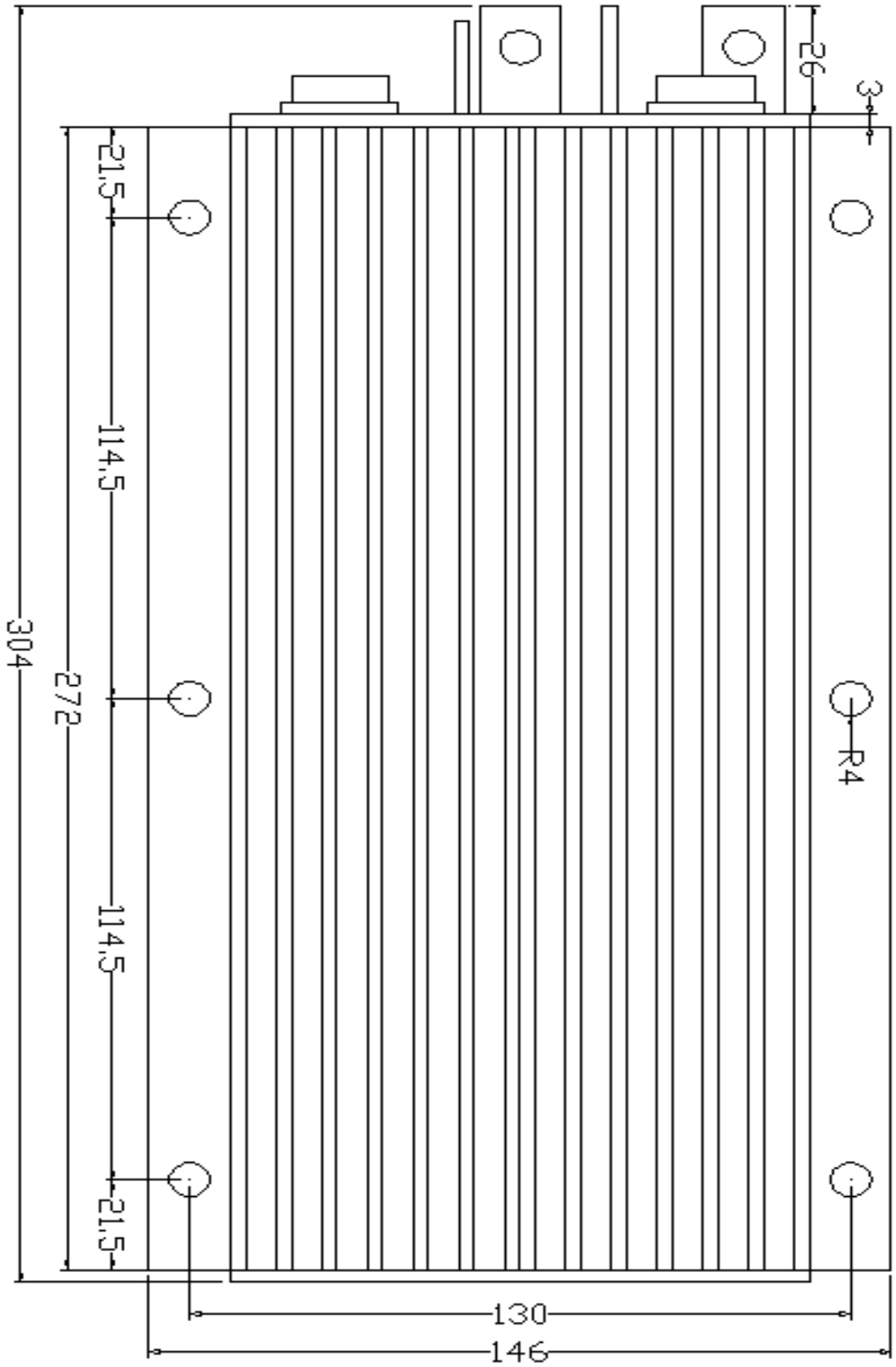
The controller can be oriented in any position as clean and dry as possible, or shield with a cover to protect it from water and contaminants.

To ensure full rated output power, the controller should be fastened to a clean, flat metal surface with four screws. A thermal joint compound can be used to improve heat conduction from the case to the mounting surface. The case outline and mounting holes' dimensions are shown in Figure 1.

Caution:

- **RUNAWAYS** — Some conditions could cause the vehicle to run out of control. Disconnect the motor, or jack up the vehicle, and get the drive wheels off the ground before attempting any work on the motor control circuitry.

- **HIGH CURRENT ARCS** — Electric vehicle batteries can supply very high power, and arcs can occur if they are short circuit. Always turn off the battery circuit before working on the motor control circuit. Wear safety glasses, and use properly insulated tools to prevent short circuit.



Height: 62 millimeters

Figure 1: mounting holes' dimensions (dimensions in millimeters)

3.2 Connections

3.2.1 Front Panel of KDC Series or PM Motor Controller:

Three metal bars and two plugs (J1, J2) are provided for connecting to the battery, motor and control signals in the front of the controller shown as Figure 2.

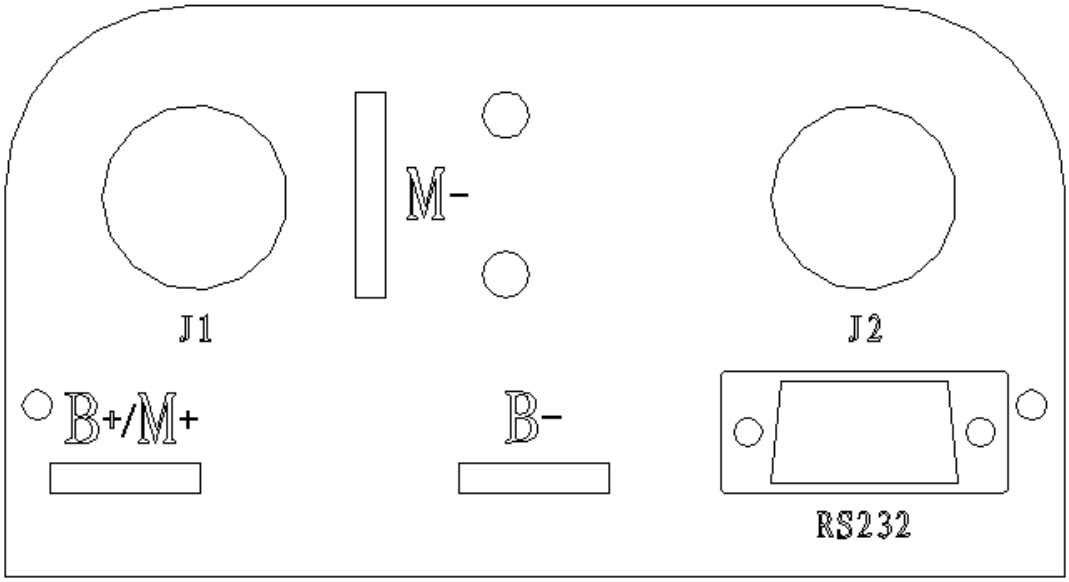


Figure 2: Front panel of KDC motor controller

B+/M+: battery positive and armature positive
B-: battery negative
M-: armature negative

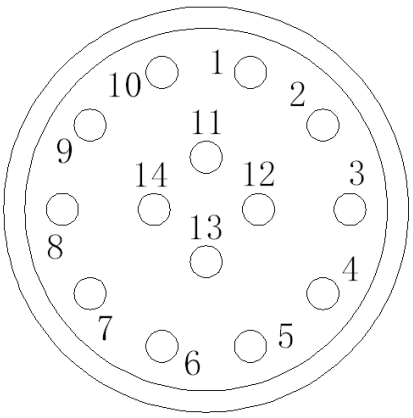


Figure 3: The connecting diagram of **J1** and **J2**

J1 Pin Definition

1- PWR: Controller power supply (output).
2- Kelly Current meter. <200mA
3- Main contactor driver. <2A
4- Alarm: To drive reverse beeper. <200mA
5- RTN: Signal return
6- Green LED: Running indication
7- RTN: Signal return
8- RS232 receiver
9- RS232 transmitter
10- CAN bus high. Optional
11- CAN bus low. Optional
12- Reserved
13- RTN: Signal return, or power supply ground

14- Red LED: Fault code.

J2 Pin Definition

1- PWR: Controller power supply (input)
2- RTN: Signal return, or power supply ground
3- RTN: Signal return
4- 12V high-level brake and motor temperature input. Demand use KTY83-122 Silicon temperature sensors.
5- Throttle analog input, 0-5V
6- Brake analog input, 0-5V
7- 5V: 5V supply output. <40mA
8- Micro_SW: Throttle switch input
9- Reversing switch input
10- Brake switch input
11- Reserved
12- Reserved
13- Reserved
14- RTN: Signal return

Notes:

1. All RTN pins are internally connected.
2. Two PWR pins, J1-1 and J2-1, are internally connected. It's recommended to use J1-1 to supply peripherals like alarm and contactor. Twist peripheral wires with PWR is the preferred for EMC. Recirculation diodes are provided in the controller to PWR for alarm and Contact coil drivers.
3. Kelly Ampmeter positive connect to 5V power supply of controller, negative to J1-2.
4. Switch to ground is active. Open switch is inactive.

Caution: Make sure all connections are correct before applying power. Otherwise it may damage the controller! Please securely wire B- before applying power. It's preferred to place contactor or breaker on B+. Please place precharge resistor on any breaker! It can cause damage without it!!!

3.2.2 Standard Wiring of KDC Series or PM Motor Controller

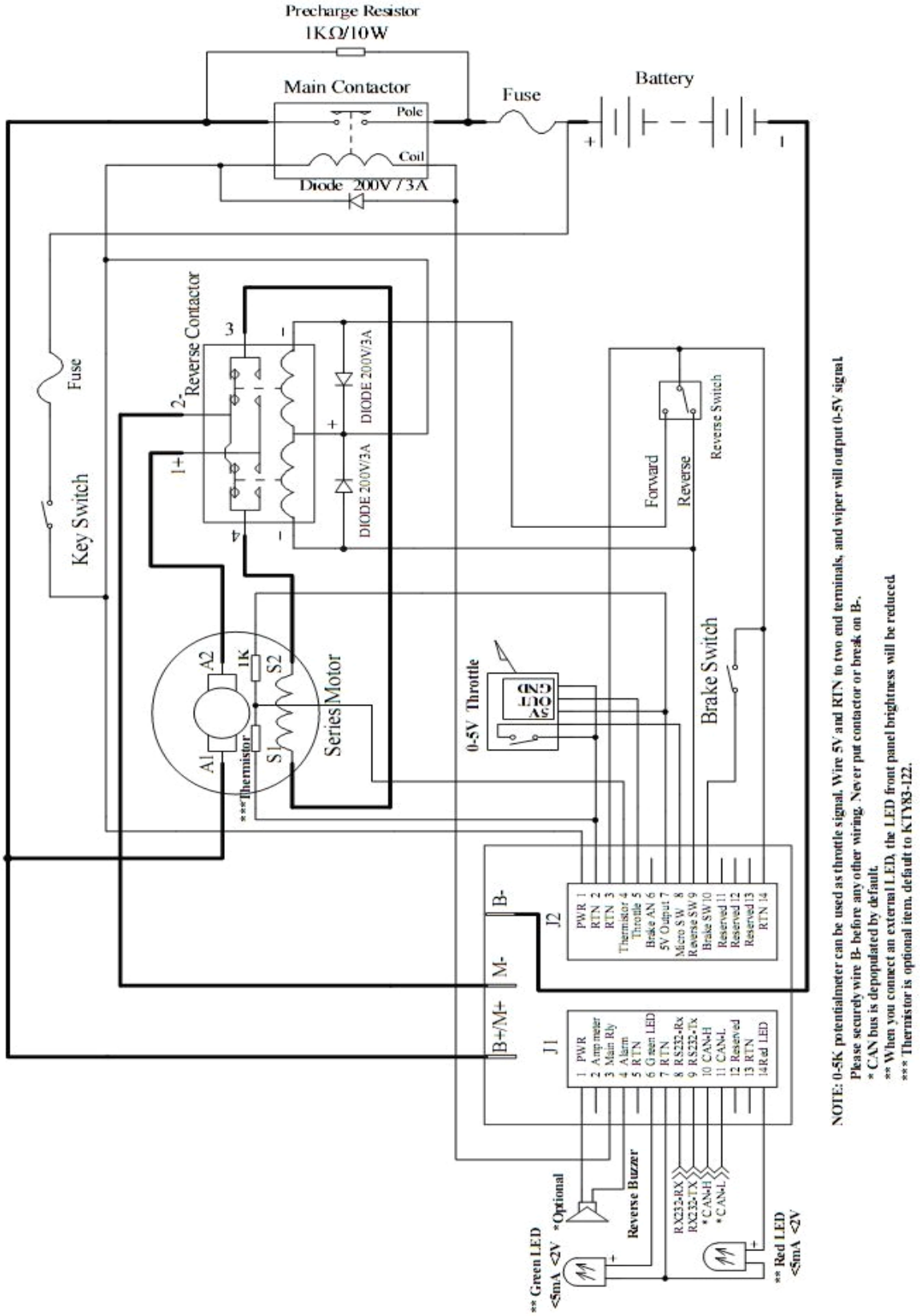


Figure 4: KDC series motor controller standard wiring

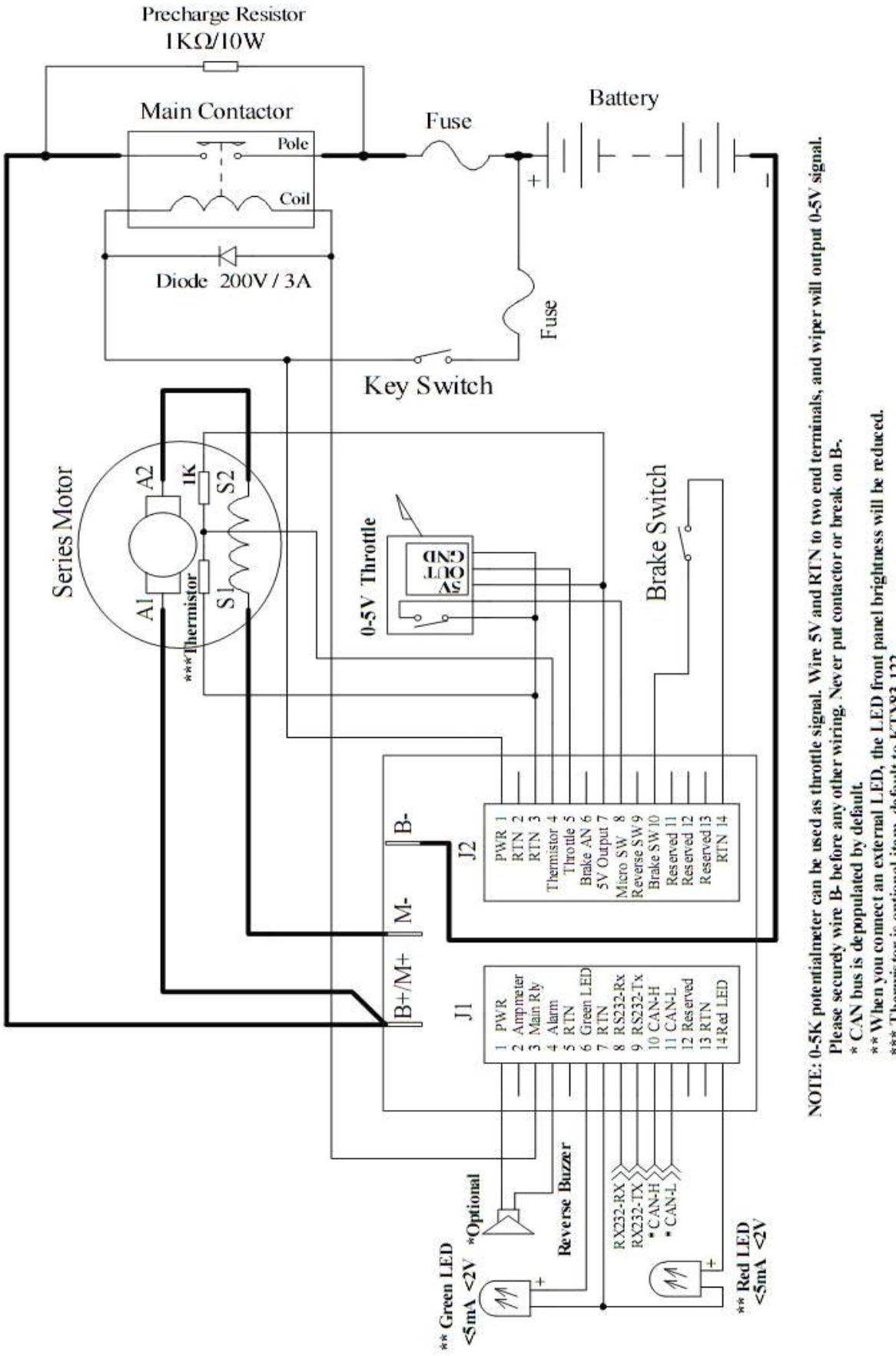


Figure 5: KDC Series motor controller standard wiring without Reversing Contactor

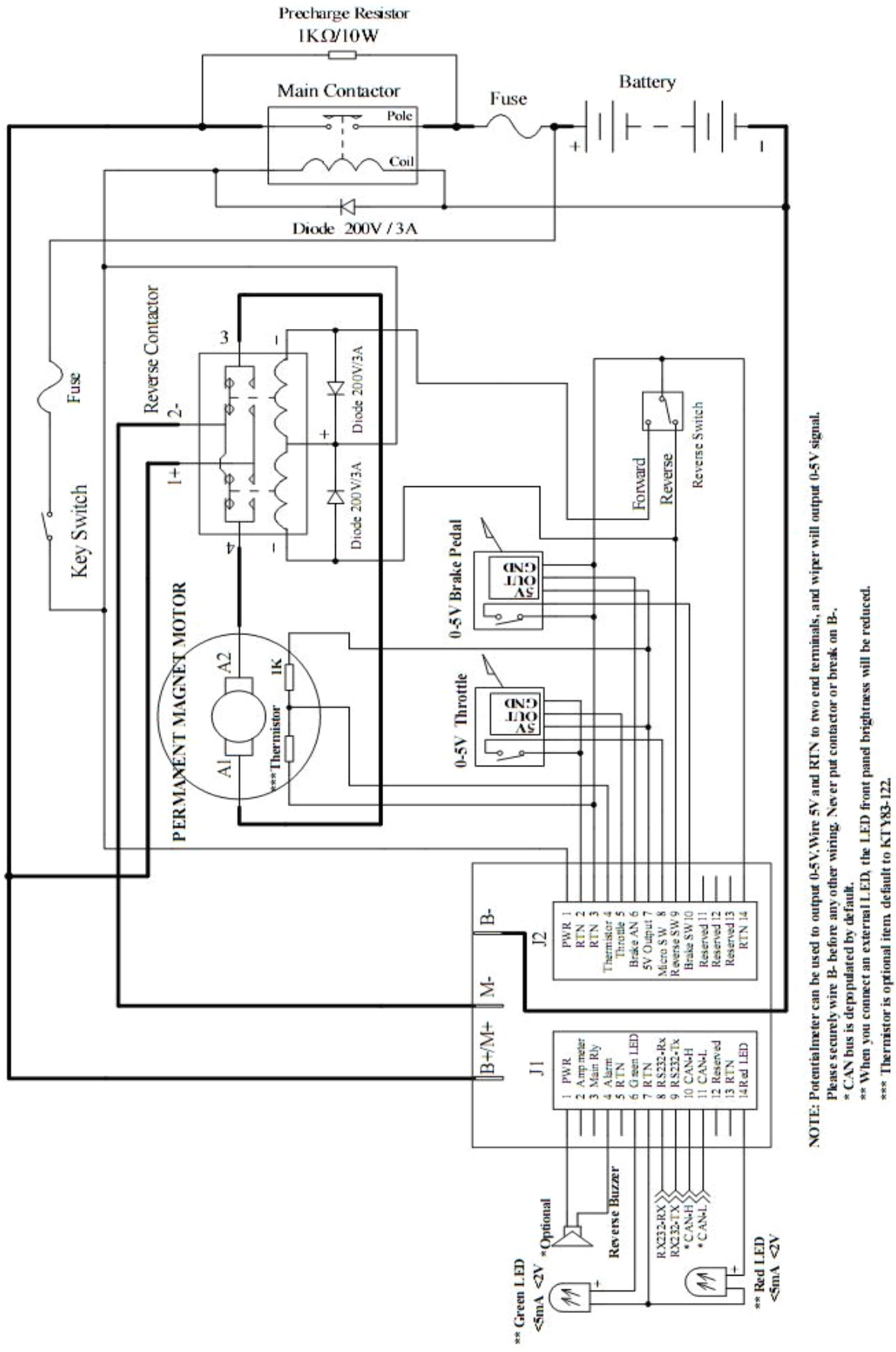


Figure 6: KDC PM motor controller standard wiring

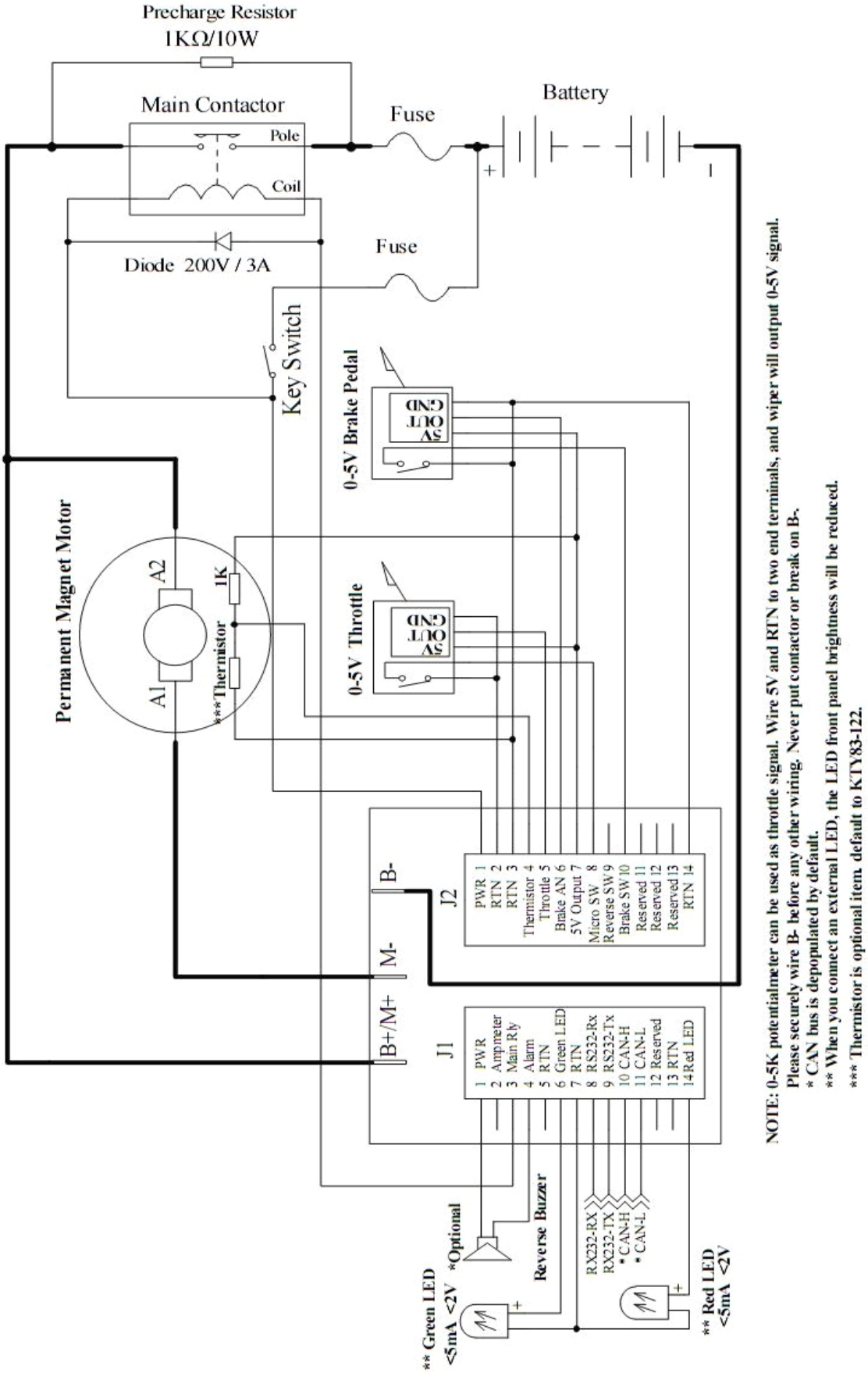


Figure 7: KDC PM motor controller standard wiring without Reversing Contactor

3.2.3 Front Panel of KDC Sep/Ex Motor Controller

Five metal bars and two plugs (J1, J2) are provided for connecting to the battery, motor and control signals in the front of the controller shown as Figure 8.

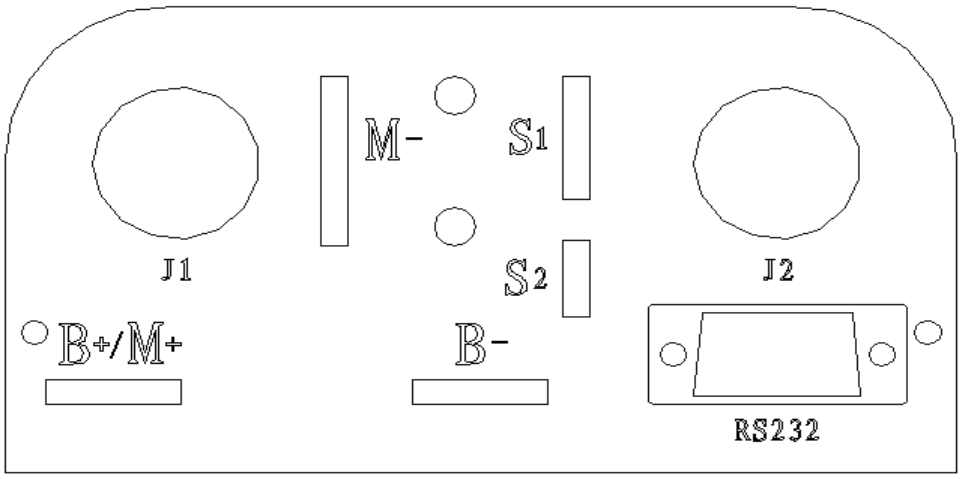


Figure 8: Front panel of KDC Sep/Ex Controller

B+/M+: battery positive and armature positive
B-: battery negative
M-: armature negative
S1: Field positive
S2: Field negative
S1 and S2: Connect to motor field coil. Motor moves forward when current flow from S1 to S2, in the case of REV switch open.

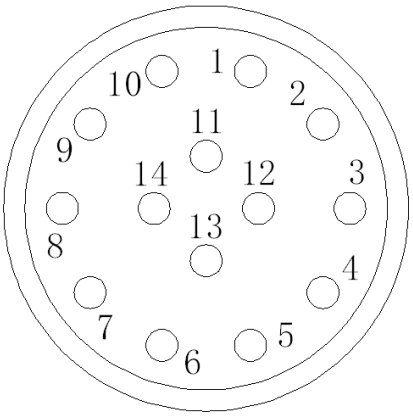


Figure9: The connecting diagram of **J1** and **J2**

J1 Pin Definition

- **1- PWR: Controller power supply (output).**
- **2- Kelly Current meter. <200mA,**
- **3- Main contactor driver. <2A, Not be used for 120V system**
- **4- Alarm: To drive reverse beeper. <200mA, Not be used for 120V system**
- **5- RTN: Signal return**
- **6- Green LED: Running indication**
- **7- RTN: Signal return**
- **8- RS232 receiver**
- **9- RS232 transmitter**
- **10- CAN bus high. Optional**
- **11- CAN bus low. Optional**
- **12- Reserved**
- **13- RTN: Signal return, or power supply ground**
- **14- Red LED: Fault code.**

J2 Pin Definition

1- PWR: Controller power supply (input)
2- RTN: Signal return, or power supply ground
3- RTN: Signal return
4- Motor temperature input. Demand use KTY83-122 Silicon temperature sensors.
5- Throttle analog input, 0-5V
6- Brake analog input, 0-5V
7- 5V: 5V supply output. <40mA
8- Micro_SW: Throttle switch input
9- Reversing switch input
10- Brake switch input
11- Reserved
12- Reserved
13- Reserved
14- RTN: Signal return

Notes:

1. All RTN pins are internally connected.
2. Two PWR pins, J1-1 and J2-1, are internally connected. It's recommended to use J1-1 to supply peripherals like alarm and contactor. Twist peripheral wires with PWR is the preferred for EMC. Recirculation diodes are provided in the controller to PWR for alarm and meter drivers.
3. Kelly Ampmeter positive connect to 5V power supply of controller, negative to J1-2.
4. Switch to ground is active. Open switch is inactive.

Caution: Make sure all connections are correct before applying power. Otherwise it may damage the controller! Please securely wire B- before applying power. It's preferred to place contactor or breaker on B+. Please place precharge resistor on any breaker! It can cause damage without it!!!

3.2.4 Standard Wiring of KDC Sep/Ex Motor Controller

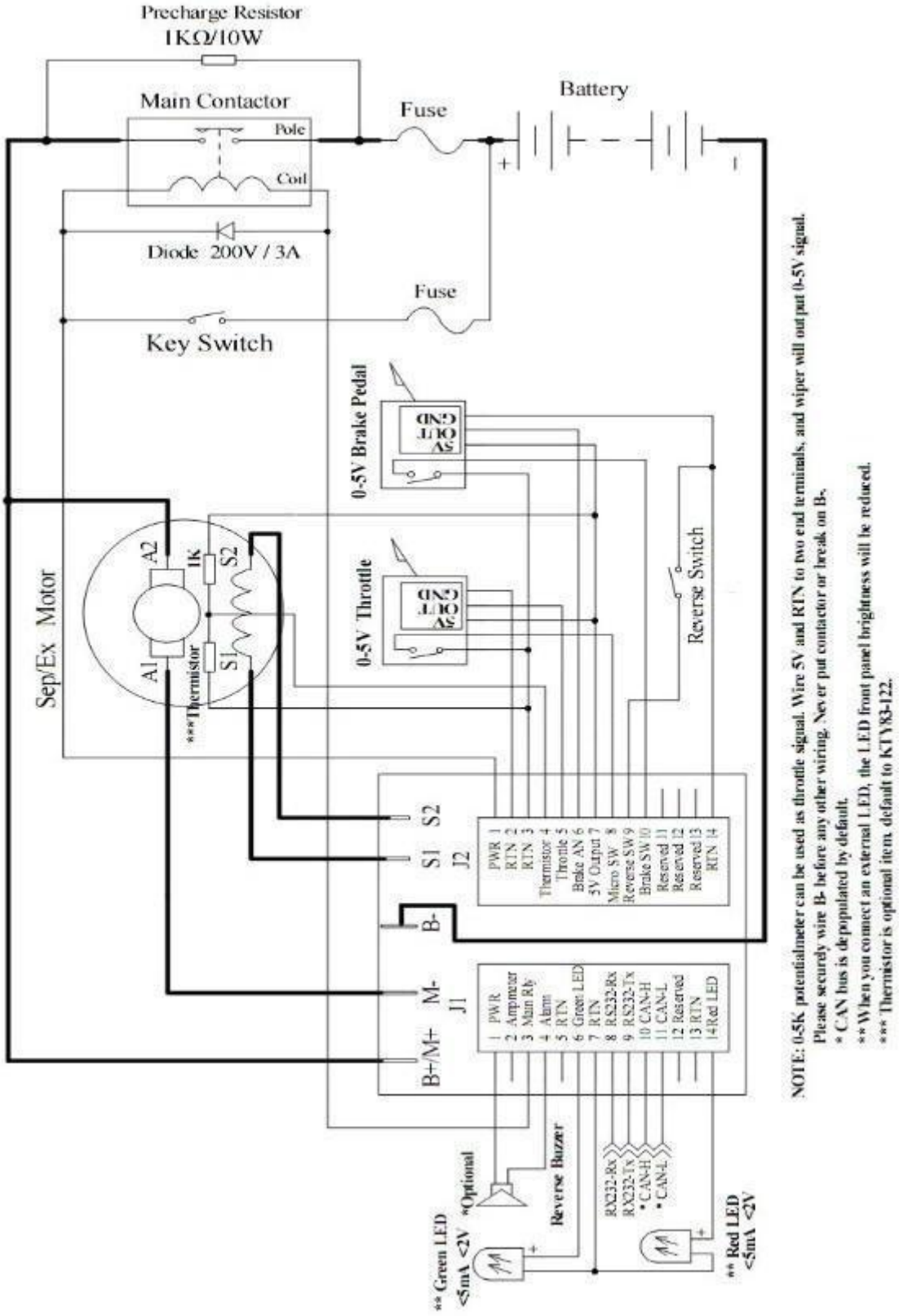


Figure 10: Sep-Ex Motor Controller Standard Wiring

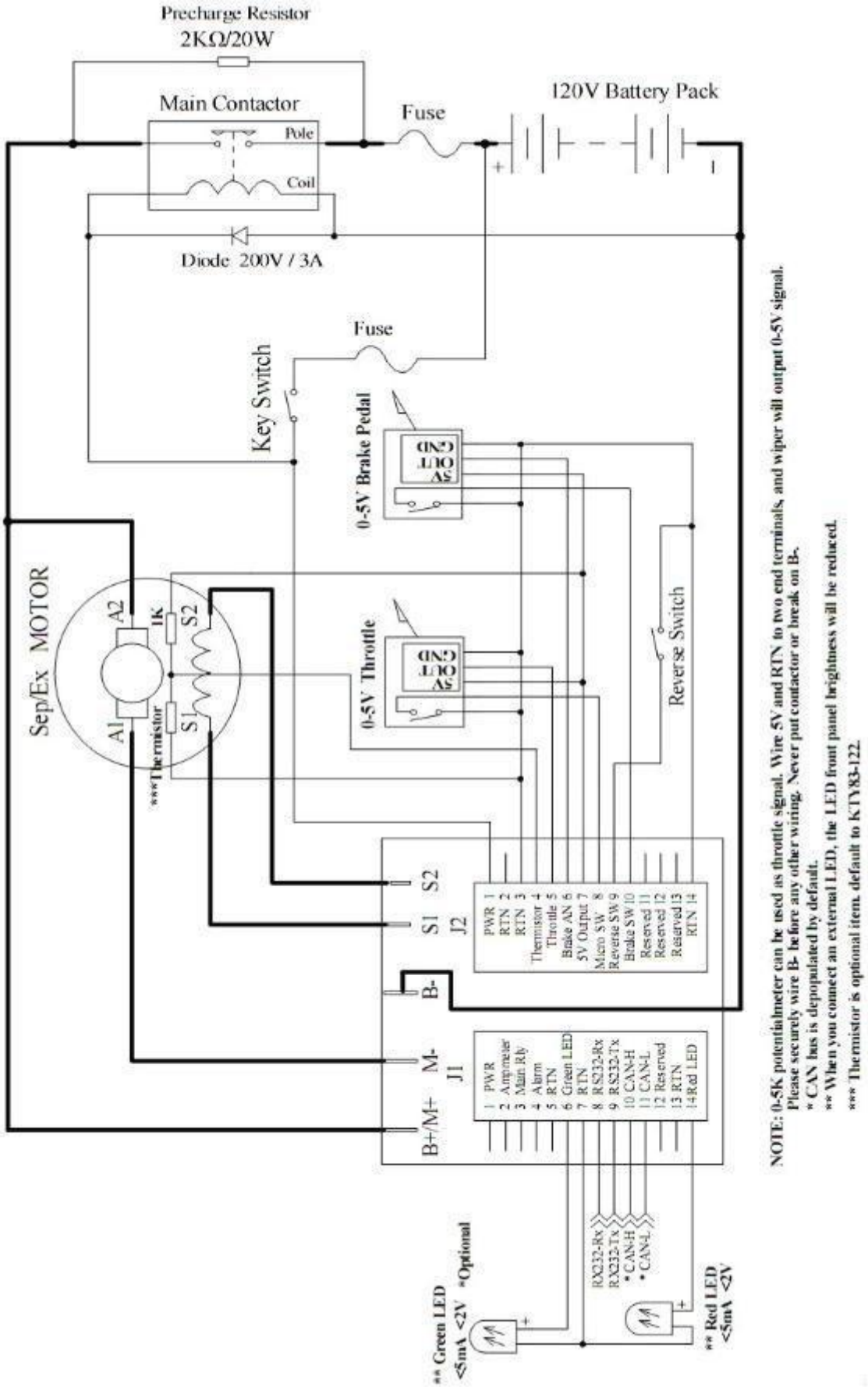


Figure 11: 120V Sep-Ex Motor Controller Standard Wiring

3.2.5 Communication Port

A RS232 port of controller is provided to communicate with host computer for calibration and configuration.

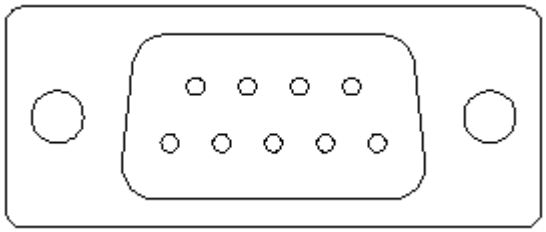


Figure 12: standard RS232 interface

3.3 Installation Checklist

Before operating the vehicle, complete the following checkout procedures. Use LED code as a reference. The LED codes are listed in Table 1.

Caution:
- Put the vehicle up on blocks to get the drive wheels off the ground before beginning these tests.
- Do not allow anyone to stand directly in front of or behind the vehicle during the checkout.
- Make sure both the PWR switch and the brake are off.
- Use well-insulated tools.

- Make sure the wire is connected correctly.
- Turn the PWR switch on. The LED should blink, then keep on when the controller operates normally. If this does not happen, check continuity of the PWR and controller ground.
- The fault code will be detected automatically at restart.
- With the brake switch open, select a direction and operate the throttle. The motor should spin in the selected direction. Please verify wiring and voltage if it doesn't operated. Also check fuse. The motor should run faster with increasing throttle. If not, refer to Table 1 LED code, and correct the fault according to the code.
- Take the vehicle off the blocks and drive it in a clear area. It should have smooth acceleration and good top speed.

Chapter 4 Maintenance

There are no user-serviceable parts inside the controllers. Do not attempt to open the controller. Or you will damage it. However, clearing the controller exterior periodically should be necessary.

The controller is inherently a high power device. When working with any battery powered vehicle, proper safety precautions should be taken. These include, but are not limited to: proper training, wearing eye protection, avoiding loose clothing and jewelry, and using insulated wrenches.

4.1 Cleaning

Although the controller requires virtually no maintenance after properly installation, the following minor maintenance is recommended in certain applications.

- Remove power by disconnecting the battery.
- Discharge the capacitors in the controller by connecting a load (such as a contactor coil or a horn) across the controller's B+ and B- terminals.
- Remove any dirt or corrosion from the bus bar area. The controller should be wiped down with a moist rag. Be sure it is dry before reconnecting the battery.
- Make sure the connections to the bus bars are tight. Use two wrenches for this task in order to avoid stressing the bus bars; the wrenches should be well insulated.

4.2 Configuration

You can configure the controller with a host computer through RS232 or USB port.

- Use a standard RS232 cable or Kelly standard USB To RS232 Converter to connect the 9 pin connector on face panel to a host computer. The cable should be straight.
- Provide >18V supply to PWR (either J2 pin1 or J1 pin1). Wire power supply ground to any RTN pin.
- Do not connect B+, throttle and so on. The controller may display fault code in some conditions, but it doesn't affect programming or configuration.

Download and setup the configuration software：

http://www.kellycontroller.com/support.php

Caution:
•Prohibit connecting controller's configuration software when the motor is running.
•Configuration software will be regularly updated and published on the website. Please regularly uninstall the previous configuration software from your computer, download and install the new one.

Table 1: LED CODES

LED Code		Explanation	Solution
Green Off	▬▬▬	No power or not operating	1. Check if all wires are correct. 2. Check fuse and power supply.
Green On	▭▭▭	Normal operation	That's great! You got solution!
1,2	¤ ¤¤	Over voltage error	1. Battery voltage is higher than max operating voltage of the controller. Please check the battery voltage and configuration. 2. Over voltage at regeneration. Controller will cut back or stop regeneration. 3. Please note there could be 2% error with Overvoltage setting.
1,3	¤ ¤¤¤	Low voltage error	1. The controller will attempt to clear the fault code automatically after 5 second if battery voltage returns to normal. 2. Check the battery voltage. 3. Charge battery if necessary.
1,4	¤ ¤¤¤¤	Over temperature warning	1. The controller temperature is over 90℃. The controller will cut back current in the case. Stop or reduce output to ensure the temperature fall. 2. Improve heat sink or airflow.
2,2	¤¤ ¤¤	Internal voltage fault	1. Check if the B+ and PWR voltage are correct, refer to B- or RTN. Could be PWR voltage low. 2. Please check load on 5V supply. Could be high load on 5V. Incorrect pot wiring can load it heavily。 1. The controller is damaged. Please contact Kelly for warrantee.
2,3	¤¤ ¤¤¤	Over temperature	1. The controller temperature is over 100℃. Controller stops driving in order to protect itself. 2. Stop driving and wait for temperature fall. The controller will restart if temperature drops below 80℃.
2,4	¤¤ ¤¤¤¤	Throttle error at power up	1. The throttle got effective signal at key-on. Cycle throttle can remove the error. You may reconfigure throttle effective range or foot switch 2. The acceleration throttle must be turned from zero up to high when the brake is released. Otherwise the controller will report this fault.
3,1	¤¤¤ ¤	Frequent reset	1. It can be caused by over current, bad motor, bad ground wiring or so.
3,2	¤¤¤ ¤¤	Internal reset	Reset caused by over current, high battery voltage

			or low supply voltage. It is normal if occurs occasionally.
3,3	¤¤¤ ¤¤¤	Wrong connection of throttle	1.Valid signal of throttle is about 1V-4V. Fault report because signal is less than 0.5V or greater than 4.5V.
3,4	¤¤¤ ¤¤¤¤	Throttle isn't zero when try to change direction	The controller will stop output in the case. Cycle throttle can clear the error.
4,1	¤¤¤¤ ¤	Over voltage error at regeneration	1. The voltage is higher than configured overvoltage value. The controller can resume operation when voltage lowered and brake cycled.
4,2	¤¤¤¤ ¤¤	Field error	1. Field do not reach configured current. 2. Field circuit open. Please check field wiring.
4, 3	¤¤¤¤ ¤¤¤	Motor over temperature	1.The motor temperature is higher than configured max temperature. Controller will shut down and wait for motor temperature dropping. 2.Can change the temperature setting with configuration program.
The Red LED flashes once at power on, then keeps off for normal operation. "1, 2" means it flashed once, then flashes twice after 1 second. The time between two flashes is 0.5 second. The pause time between one error code and another error code is 2 second.			

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